



TEST REPORT

Test Report No. : UL-RPT-RP10850027JD03A V2.0

Manufacturer : Cipher Surgical Ltd
Model No. : CS-CU15-03
FCC ID : 2AGUPCS-CU15-03
Technology : RFID – 13.56 MHz
Test Standard(s) : FCC Parts 15.207, 15.209(a) & 15.225

1. This test report shall not be reproduced in full or partial, without the written approval of UL VS LTD.
2. The results in this report apply only to the sample(s) tested.
3. The sample tested is in compliance with the above standard(s).
4. The test results in this report are traceable to the national or international standards.
5. Version 2.0 supersedes all previous versions.

Date of Issue: 29 February 2016

Checked by:

Ian Watch
Senior Engineer, Radio Laboratory

Company Signatory:

Steven White
Service Lead, Radio Laboratory,
UL VS LTD



This laboratory is accredited by UKAS.
The tests reported herein have been
performed in accordance with its terms
of accreditation.

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1. Customer Information

Company Name:	Cipher Surgical Ltd
Address:	The Venture Centre Sir William Lyons Road Coventry CV4 7EZ United Kingdom

2. Summary of Testing

2.1. General Information

Specification Reference:	47CFR15.225
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Radio Frequency Devices) - Section 15.225
Specification Reference:	47CFR15.207 and 47CFR15.209
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Sections 15.207 and 15.209
Site Registration:	209735
Location of Testing:	UL VS LTD, Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom
Test Dates:	01 February 2016 to 23 February 2016

2.2. Summary of Test Results

FCC Reference (47CFR)	Measurement	Result
Part 15.207	Transmitter AC Conducted Emissions	
Part 15.225(a)(b)(c)(d)	Transmitter Fundamental Field Strength	
Part 15.209(a)/15.225(d)	Transmitter Radiated Emissions	
Part 15.209(a)/15.225(c)(d)	Transmitter Band Edge Radiated Emissions	
Part 15.225(e)	Transmitter Frequency Stability (Temperature & Voltage Variation)	
Key to Results  = Complied  = Did not comply		

2.3. Methods and Procedures

Reference:	ANSI C63.10-2013
Title:	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
Reference:	FCC KDB Publication Number 937606 Date: 10/10/2014
Title:	Test Site Requirements for Part 15 and 18 Devices Operating Below 30 MHz
Reference:	FCC KDB Publication Number 174176 Date: June 3, 2015
Title:	AC Power-Line Conducted Emissions Frequently Asked Questions.

2.4. Deviations from the Test Specification

For the measurements contained within this test report, there were no deviations from, additions to, or exclusions from the test specification identified above.

3. Equipment Under Test (EUT)

3.1. Identification of Equipment Under Test (EUT)

Brand Name:	OpClear Control Unit
Model Name or Number:	CS-CU15-03
Test Sample Serial Number:	CS-CU-003-00015 (<i>Radiated sample</i>)
Hardware Version:	CU3
Software Version:	UL-3
FCC ID:	2AGUPCS-CU15-03

Brand Name:	OpClear Control Unit
Model Name or Number:	CS-CU15-03
Test Sample Serial Number:	CS-CU-003-00014 (<i>AC conducted emissions sample – Modified antenna</i>)
Hardware Version:	CU3
Software Version:	UL-3
FCC ID:	2AGUPCS-CU15-03

3.2. Description of EUT

The Equipment Under Test was a medical control unit for use in hospital operating theatres. It contains an RFID module transmitting at 13.56 MHz. The unit is powered from a single phase AC supply.

3.3. Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing.

3.4. Additional Information Related to Testing

Tested Technology:	RFID	
Category of Equipment:	Transceiver	
Channel Spacing:	Single channel device	
Modulation:	Amplitude Modulation	
Transmit Frequency:	13.561800 MHz	
Power Supply Requirement:	Nominal	120 VAC 60 Hz / 240 VAC 60 Hz
Tested Temperature Range:	Minimum	5 °C
	Maximum	30 °C

3.5. Support Equipment

The following support equipment was used to exercise the EUT during testing:

Description:	Foot switch
Brand Name:	Not marked or stated
Model Name or Number:	6448-0035
Serial Number:	Not marked or stated

Description:	Disposable tube
Brand Name:	Not marked or stated
Model Name or Number:	SI2 Storz 30
Serial Number:	CS-SZ-10-00

Description:	Air compressor
Brand Name:	Stanley
Model Name or Number:	D/N 55/8/5
Serial Number:	8213360SCR001

Description:	Air supply pipe
Brand Name:	Not marked or stated
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

4. Operation and Monitoring of the EUT during Testing

4.1. Operating Modes

The EUT was tested in the following operating mode(s):

- Constantly transmitting at full power with a modulated carrier in RFID test mode.

4.2. Configuration and Peripherals

The EUT was tested in the following configuration(s):

- The EUT was configured in accordance with the customer's document C001826 CU3 User Manual ver 4.pdf. A plastic air hose was connected between the EUT and an air compressor. The footswitch was pressed for 2 seconds to place the EUT into RFID test mode
- Both units used for testing had test software UL-3 installed. This version enabled continuous transmission of the RFID signal.
- Testing at voltage extremes was performed with the EUT connected to a variable AC power supply.
- All unused active ports were terminated.

5. Measurements, Examinations and Derived Results

5.1. General Comments

Measurement uncertainties are evaluated in accordance with current best practice. Our reported expanded uncertainties are based on standard uncertainties, which are multiplied by an appropriate coverage factor to provide a statistical confidence level of approximately 95%. Please refer to *Section 6: Measurement Uncertainties* for details.

In accordance with UKAS requirements all the measurement equipment is on a calibration schedule. All equipment was within the calibration period on the date of testing.

5.2. Test Results

5.2.1. Transmitter AC Conducted Spurious Emissions

Test Summary:

Test Engineer:	Andrew Edwards	Test Dates:	01 February 2016 & 12 February 2016
Test Sample Serial Numbers:	CS-CU-003-00015 & CS-CU-003-00014		

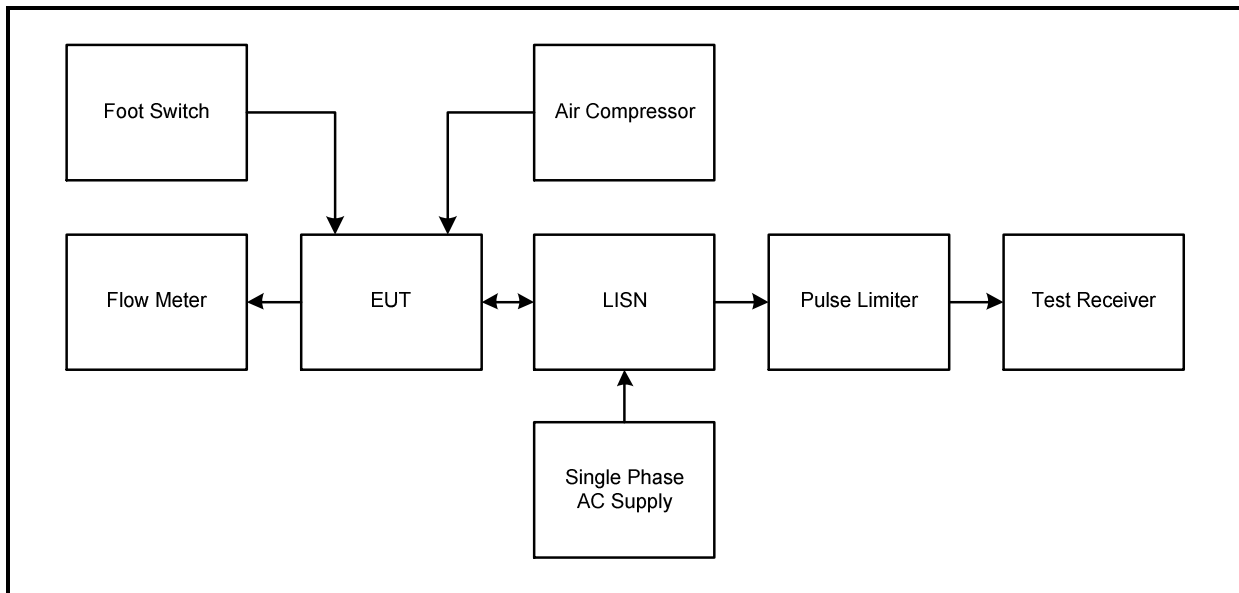
FCC Reference:	Part 15.207
Test Method Used:	ANSI C63.10 Section 6.2 / FCC KDB 174176 and Notes below

Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	35 to 44

Note(s):

1. The EUT was connected to a single phase supply via a LISN.
2. A pulse limiter was fitted between the LISN and the test receiver.
3. Pre-scans were performed and markers placed on the highest live and neutral measured levels. Final measurements were performed on the marker frequencies and the results entered into the tables below.
4. The EUT was initially tested with the standard antenna connected (Test sample Serial No. CS-CU-003-00015) and using a 120 VAC 60 Hz single phase supply. An emission at the approximate carrier frequency of 13.56 MHz was found to be non-compliant as it exceeded the test limit. The customer supplied a second, modified sample (Test sample Serial No. CS-CU-003-00014). The standard antenna was disconnected and a dummy load fitted in accordance with FCC KDB 174176. The test was repeated and the EUT was found to be compliant.
5. *Test results with modified sample (transmitter terminated into a dummy load/Test sample Serial No. CS-CU-003-00014). All other measurements were performed with the standard antenna / Test sample Serial No. CS-CU-003-00015).
6. Tests were repeated using a 240 VAC 60 Hz supply. The emission level of the fundamental at approximately 13.56 MHz was found to be below the relevant limits, therefore testing was only performed using a unit with the standard antenna connected.

Transmitter AC Conducted Spurious Emissions (continued)**Test setup for AC conducted spurious emissions measurements:**

Transmitter AC Conducted Spurious Emissions (continued)**Results: Live / Quasi Peak / 120 VAC 60 Hz**

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
13.560	Live	16.9*	60.0	43.1	Complied
18.780	Live	16.3	60.0	43.7	Complied
19.388	Live	17.7	60.0	42.3	Complied
19.847	Live	16.4	60.0	43.6	Complied
24.000	Live	16.7	60.0	43.3	Complied
27.123	Live	37.2	60.0	22.8	Complied

Results: Live / Average / 120 VAC 60 Hz

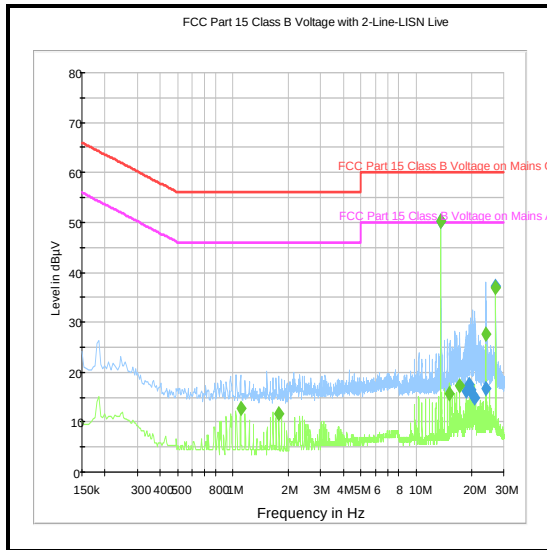
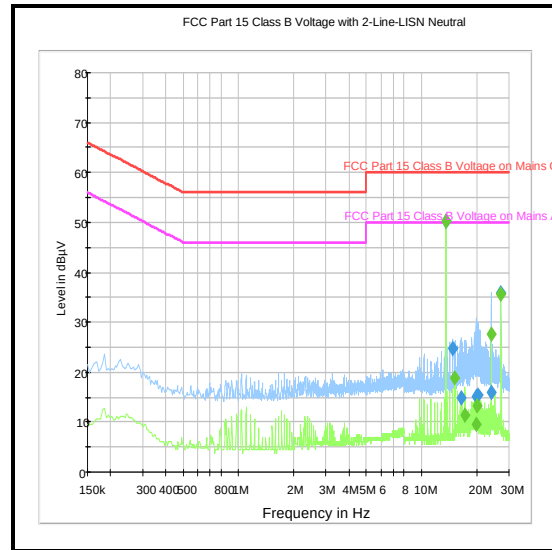
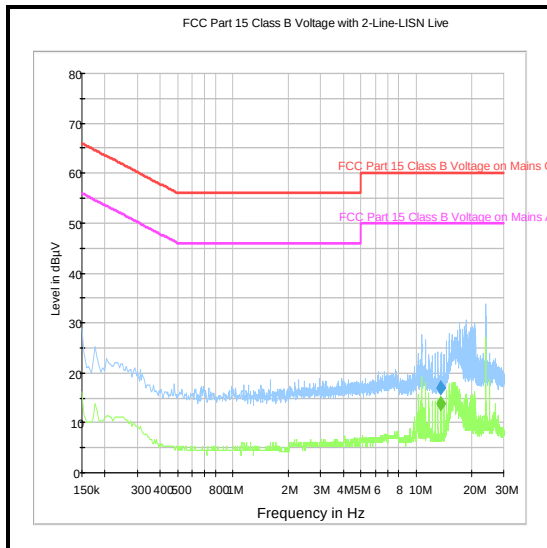
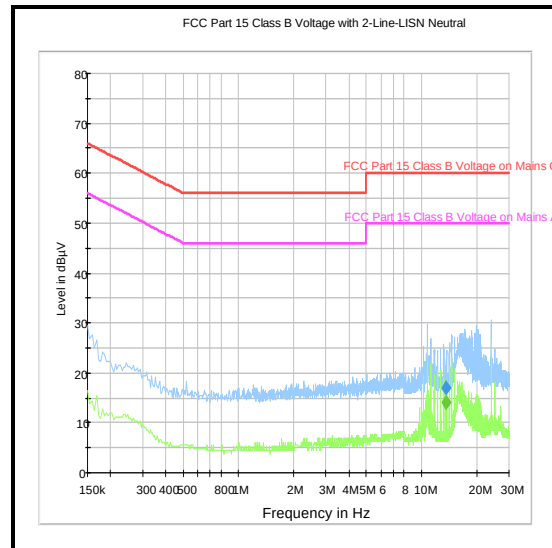
Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
1.104	Live	12.7	46.0	33.3	Complied
1.779	Live	11.6	46.0	34.4	Complied
13.560	Live	13.8*	50.0	36.2	Complied
17.138	Live	17.2	50.0	32.8	Complied
24.036	Live	27.5	50.0	22.5	Complied
27.123	Live	36.9	50.0	13.1	Complied

Transmitter AC Conducted Spurious Emissions (continued)**Results: Neutral / Quasi Peak / 120 VAC 60 Hz**

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
13.560	Neutral	17.1*	60.0	42.9	Complied
14.699	Neutral	24.7	60.0	35.3	Complied
19.797	Neutral	15.0	60.0	45.0	Complied
20.382	Neutral	15.5	60.0	44.5	Complied
24.000	Neutral	16.0	60.0	44.0	Complied
27.123	Neutral	35.9	60.0	24.1	Complied

Results: Neutral / Average / 120 VAC 60 Hz

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
13.560	Neutral	14.1*	50.0	35.9	Complied
15.180	Neutral	18.9	50.0	31.1	Complied
17.120	Neutral	11.4	50.0	38.6	Complied
20.085	Neutral	13.2	50.0	36.8	Complied
24.036	Neutral	27.6	50.0	22.4	Complied
27.123	Neutral	35.6	50.0	14.4	Complied

Transmitter AC Conducted Spurious Emissions (continued)**Test results: 120 VAC 60 Hz with unmodified sample (antenna present)****Live****Neutral****Test results: 120 VAC 60 Hz with modified sample (transmitter terminated into a dummy load)****Live – Antenna port terminated****Neutral – Antenna port terminated**

Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Transmitter AC Conducted Spurious Emissions (continued)**Results: Live / Quasi Peak / 240 VAC 60 Hz**

Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.578	Live	33.6	56.0	22.4	Complied
0.731	Live	39.3	56.0	16.8	Complied
13.560	Live	48.8	60.0	11.2	Complied
24.000	Live	43.9	60.0	16.1	Complied
24.576	Live	35.6	60.0	24.4	Complied
27.123	Live	36.7	60.0	23.3	Complied

Results: Live / Average / 240 VAC 60 Hz

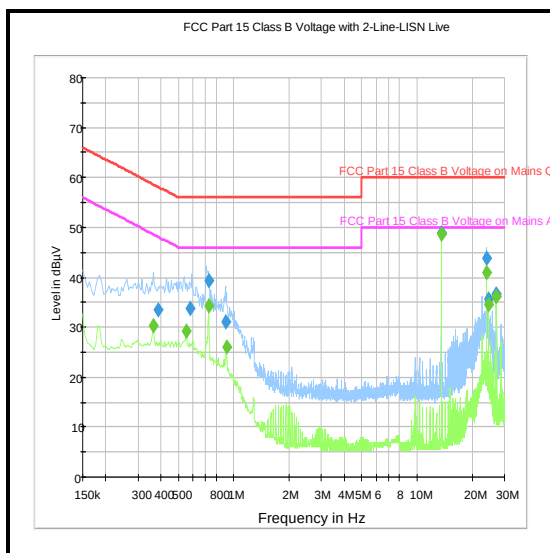
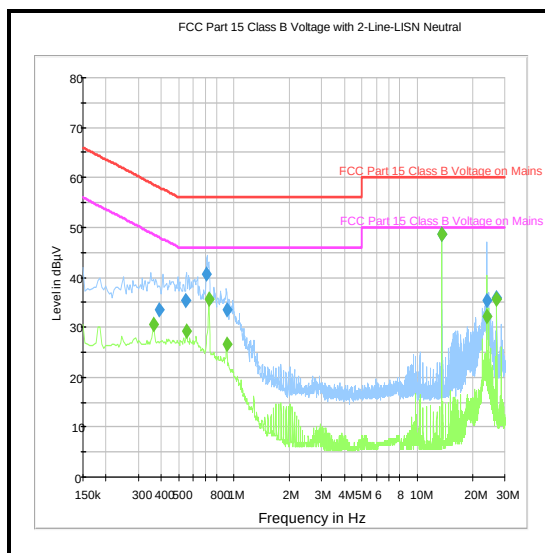
Frequency (MHz)	Line	Level (dBμV)	Limit (dBμV)	Margin (dB)	Result
0.551	Live	29.2	46.0	16.8	Complied
0.731	Live	34.2	46.0	11.8	Complied
13.560	Live	48.8	50.0	1.2	Complied
24.000	Live	41.0	50.0	9.0	Complied
24.576	Live	34.4	50.0	15.6	Complied
27.123	Live	36.2	50.0	13.8	Complied

Transmitter AC Conducted Spurious Emissions (continued)**Results: Neutral / Quasi Peak / 240 VAC 60 Hz**

Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.393	Neutral	33.6	58.0	24.4	Complied
0.546	Neutral	35.3	56.0	20.7	Complied
0.708	Neutral	40.8	56.0	15.2	Complied
0.915	Neutral	33.6	56.0	22.4	Complied
13.560	Neutral	48.7	60.0	11.3	Complied
27.123	Neutral	35.9	60.0	24.1	Complied

Results: Neutral / Average / 240 VAC 60 Hz

Frequency (MHz)	Line	Level (dB μ V)	Limit (dB μ V)	Margin (dB)	Result
0.366	Neutral	30.6	48.6	18.0	Complied
0.551	Neutral	29.2	46.0	16.8	Complied
0.731	Neutral	35.6	46.0	10.4	Complied
13.560	Neutral	48.6	50.0	1.4	Complied
24.000	Neutral	32.3	50.0	17.7	Complied
27.123	Neutral	35.6	50.0	14.4	Complied

Transmitter AC Conducted Spurious Emissions (continued)**Test results: 240 VAC 60 Hz with unmodified sample (antenna present)****Live****Neutral**

Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1625	Thermohygrometer	JM Handelspunkt	30.5015.06	Not stated	11 Jan 2017	12
M1263	Test Receiver	Rohde & Schwarz	ESIB7	100265	16 Oct 2016	12
A067	LISN	Rohde & Schwarz	ESH3-Z5	890603/002	27 Aug 2016	12
A1830	Pulse Limiter	Rohde & Schwarz	ESH3-Z2	100668	02 Mar 2016	12
M1251	Multimeter	Fluke	175	89170179	26 May 2016	12
S0539	Variable AC Power Supply	Kikusui	PCR 1000L	13010170	Calibrated before use	-

5.2.2. Transmitter Fundamental Field Strength**Test Summary:**

Test Engineer:	Andrew Edwards	Test Dates:	02 February 2016 & 12 February 2016
Test Sample Serial Number:	CS-CU-003-00015		

FCC Reference:	Part 15.225(a)(b)(c)(d)
Test Method Used:	ANSI C63.10 Section 6.4

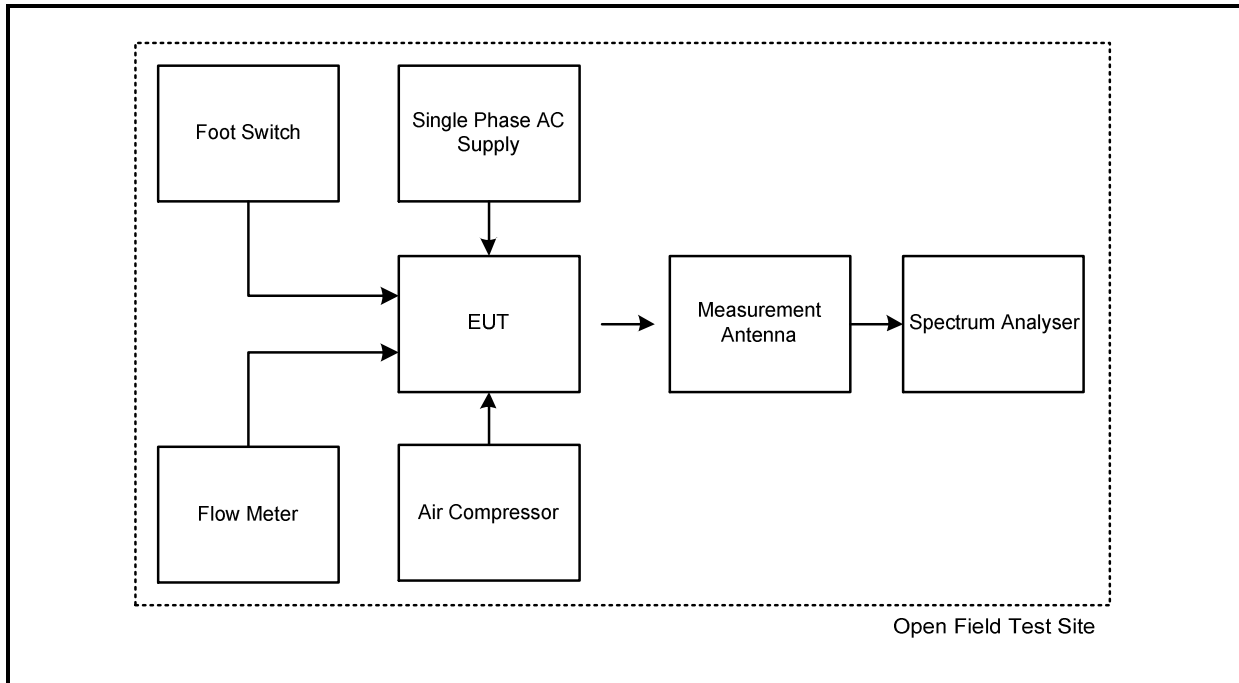
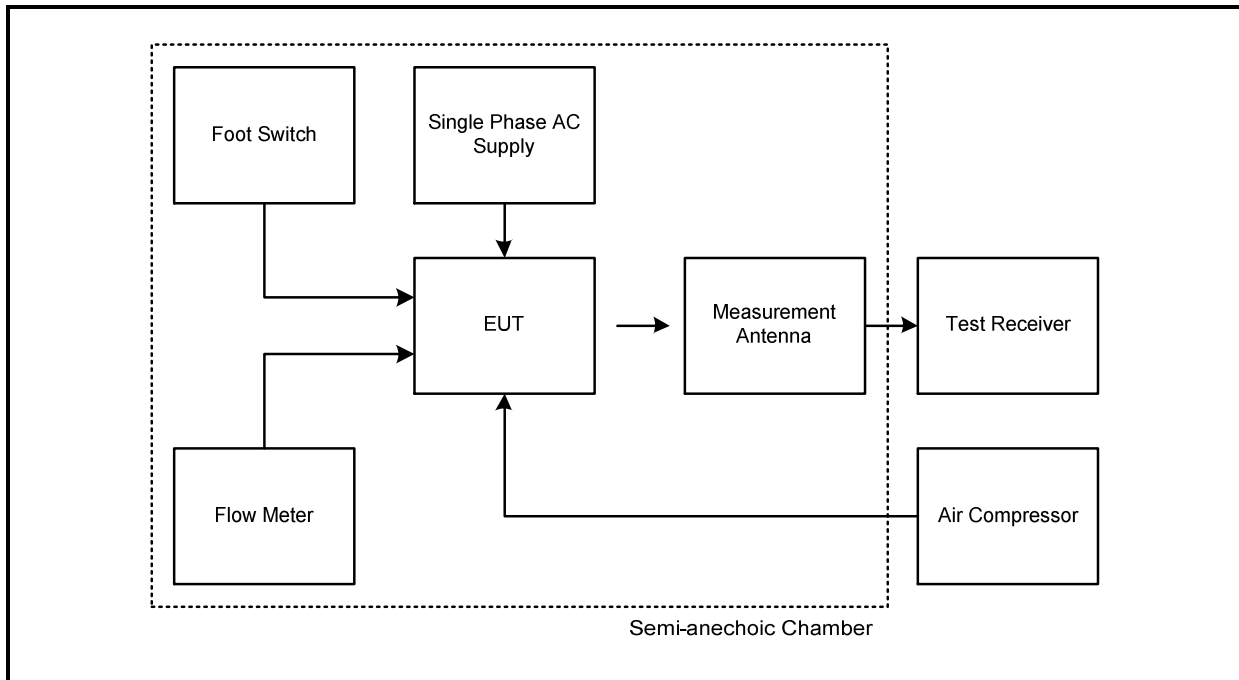
Environmental Conditions:

Temperature (°C):	10 to 25
Relative Humidity (%):	29 to 33

Note(s):

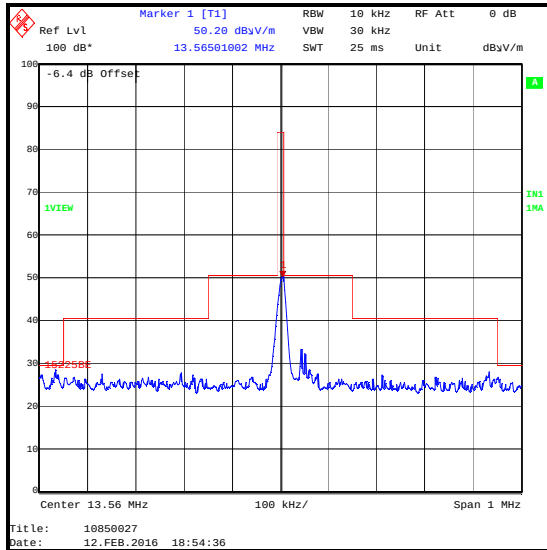
- The limit is specified at a test distance of 30 metres. However, as specified by FCC Section 15.31 (f)(2), measurements may be performed at a closer distance and the measured level corrected to the specified measurement distance by using the square of an inverse linear distance extrapolation factor (40dB/decade).
- In accordance with FCC KDB 937606, a *bona fide* attempt was made to perform measurements at the distances specified in Part 15.209(a). It was not possible to determine the emission value at the test distances specified below 30 MHz on an open field test site, therefore in accordance with 47 CFR 15.31(f), measurements were made at closer distances. Attempts were made to measure the fundamental at 30 metres on an open field test site on 02 February 2016. Unfortunately the fundamental could not be seen above the ambient emissions or the noise floor of the measurement system at a distance of 30 metres, therefore the measurement was repeated at a reduced measurement distance of 3 metres using a measurement bandwidth of 10 kHz. Ambient emissions masked the fundamental; therefore the measurement was repeated using a reduced bandwidth (resolution bandwidth 1 kHz and video bandwidth 3 kHz). The fundamental was visible with these settings. NOTE: The EUT was transmitting with 100% duty cycle; therefore the level of the fundamental remained the same with both measurement bandwidths. Background scans of the open field test site and further information are shown in Appendix 1 of this test report.
- Pre-scan measurements were performed at the open field test site and in the semi-anechoic chamber using a spectrum analyser with a peak detector and measurement bandwidth of 1 kHz. The fundamental field strength was maximized by rotating the measurement antenna and EUT. A peak level of 49.8 dBµV/m at a measurement distance of 3 metres was recorded and shown on the pre-scan plots below.
- Final measurements were performed in the semi-anechoic chamber in accordance with ANSI C63.10 Clause 4.1.4.2.1 and CISPR 16-1-1, a quasi-peak detector was used in conjunction with a measurement bandwidth of 9 kHz and 0.2 second sweep time. A level of 50.2 dBµV/m at a measurement distance of 3 metres was recorded. A further 40 dB was subtracted to extrapolate the level measured at 3 metres to the required distance of 30 metres:

$$\text{Corrected level } 50.2 - 40 = 10.2 \text{ dB}\mu\text{V/m at 30 metres.}$$
- Due to ambient emissions present on the open field test site, compliance with the spectrum mask is shown by measurements performed in a semi-anechoic chamber. For the field strength measurement in a semi-anechoic chamber, an RF level offset was applied on the measuring instrument. The results were extrapolated from 3 metres to a distance of 30 metres. A distance extrapolation factor of 40 dB was used.
- A transducer factor was used on the spectrum analyser during open field tests. This factor includes correction between the fixed gain of the magnetic loop antenna and the calibration values. It also includes the insertion loss of the RF cable used to connect the antenna to the spectrum analyser which was incorporated into the annual calibration of the magnetic loop antenna.

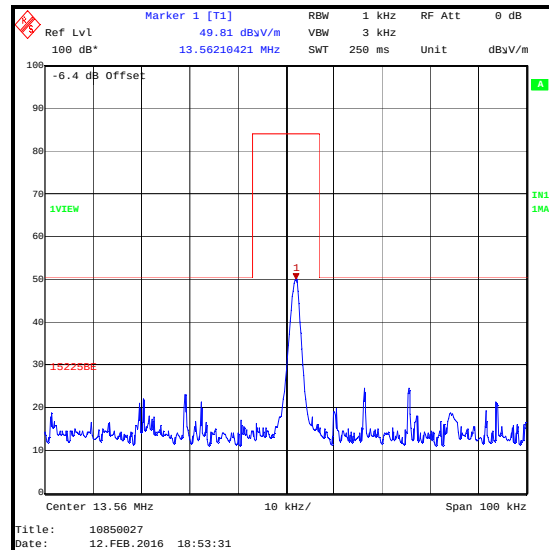
Transmitter Fundamental Field Strength (continued)**Test setup for radiated measurements: Open Field Test Site****Test setup for radiated measurements: Semi-anechoic chamber**

Transmitter Fundamental Field Strength (continued)**Results: Quasi Peak**

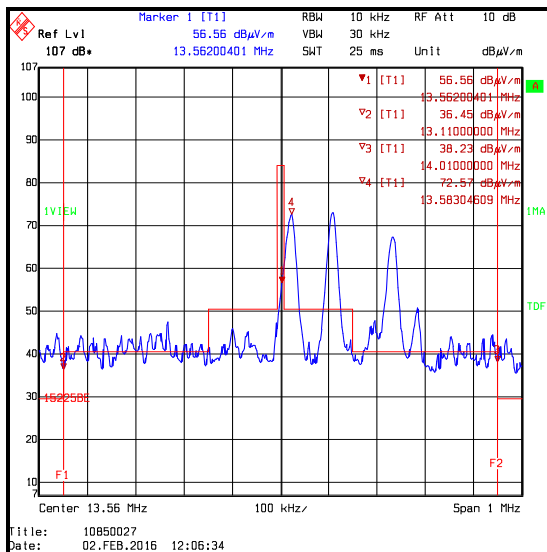
Frequency (MHz)	Measurement Antenna Position	Level (dB μ V/m)	Limit at 30 m (dB μ V/m)	Margin (dB)	Result
13.565010	Tip of antenna 90° from EUT	10.2	84.0	73.8	Complied



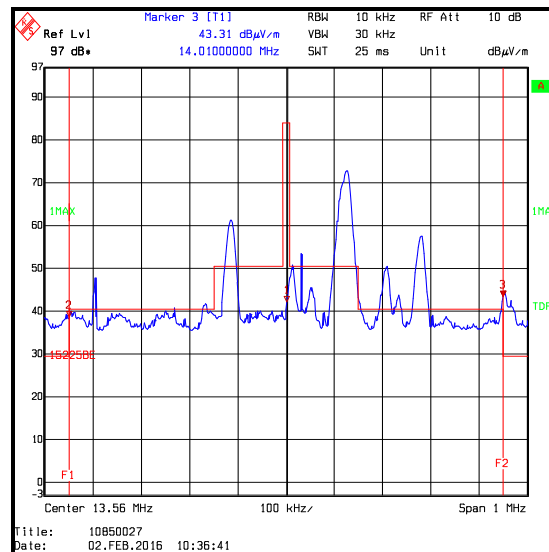
Fundamental field strength and spectrum mask / measured at 3 metres in a semi-anechoic chamber



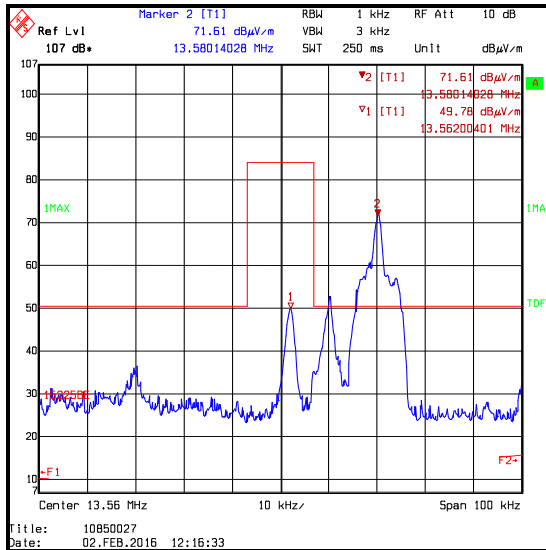
Fundamental field strength and spectrum mask / measured at 3 metres in a semi-anechoic chamber with reduced measurement bandwidth of 1 kHz



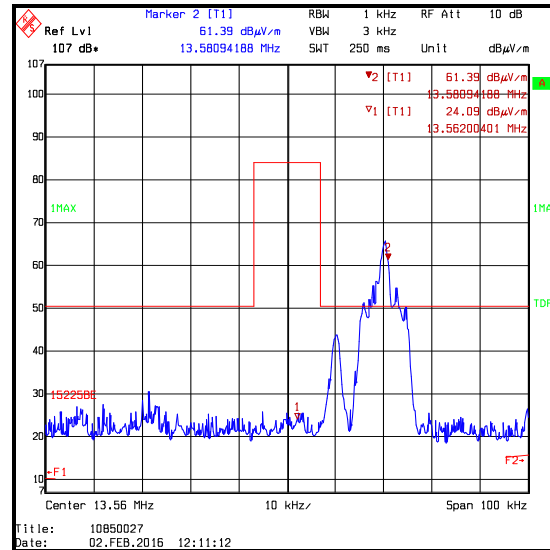
Fundamental field strength / EUT operating / measured at 3 metres / measured on an open field test site with 10 kHz measurement bandwidth (fundamental is masked by an ambient emission)



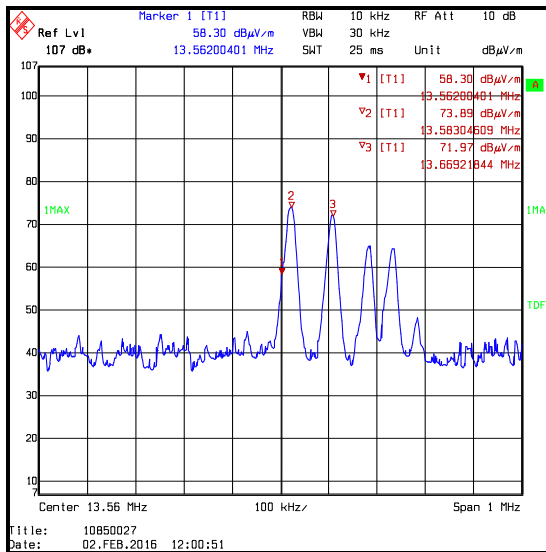
Fundamental field strength / EUT operating / measured at 30 metres / measured on an open field test site with 10 kHz measurement bandwidth (fundamental is below the noise floor / masked by an ambient emission)

Transmitter Fundamental Field Strength (continued)**Results:**

Fundamental field strength / EUT operating / measured at 3 metres / measured on an open field test site with reduced measurement bandwidth of 1 kHz



Fundamental field strength / EUT off / Background scan of the open field test site / measured on an open field test site with reduced measurement bandwidth of 1 kHz



EUT off / Background scan of the open field test site with a 10 kHz measurement bandwidth showing an unwanted ambient emission at approximately 13.56 MHz (Marker 2)

Transmitter Fundamental Field Strength (continued)**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1623	Thermohygrometer	JM Handelspunkt	30.5015.13	Not stated	11 Jan 2017	12
K0001	5m RSE Chamber	Rainford EMC	N/A	N/A	12 Jan 2017	12
M1273	Test Receiver	Rohde & Schwarz	ESIB26	100275	19 Mar 2016	12
M1659	Thermohygrometer	JM Handelspunkt	30.5015.13	Not stated	23 Apr 2016	12
M127	Spectrum Analyser	Rohde & Schwarz	FSEB30	842659/016	11 Aug 2016	12
M1568	Magnetic Loop Antenna	Rohde & Schwarz	HFH2-Z2	879284/2	06 May 2016	12

5.2.3. Transmitter Radiated Spurious Emissions

Test Summary:

Test Engineer:	Andrew Edwards	Test Dates:	02 February 2016 & 03 February 2016
Test Sample Serial Number:	CS-CU-003-00015		

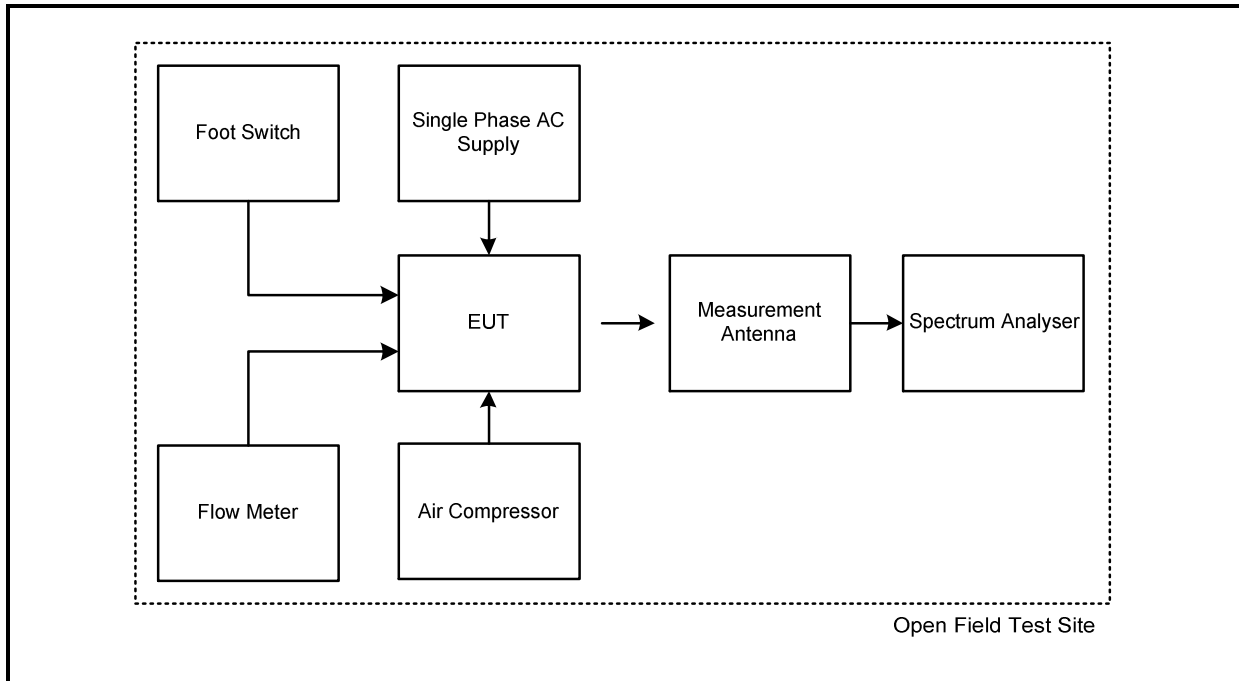
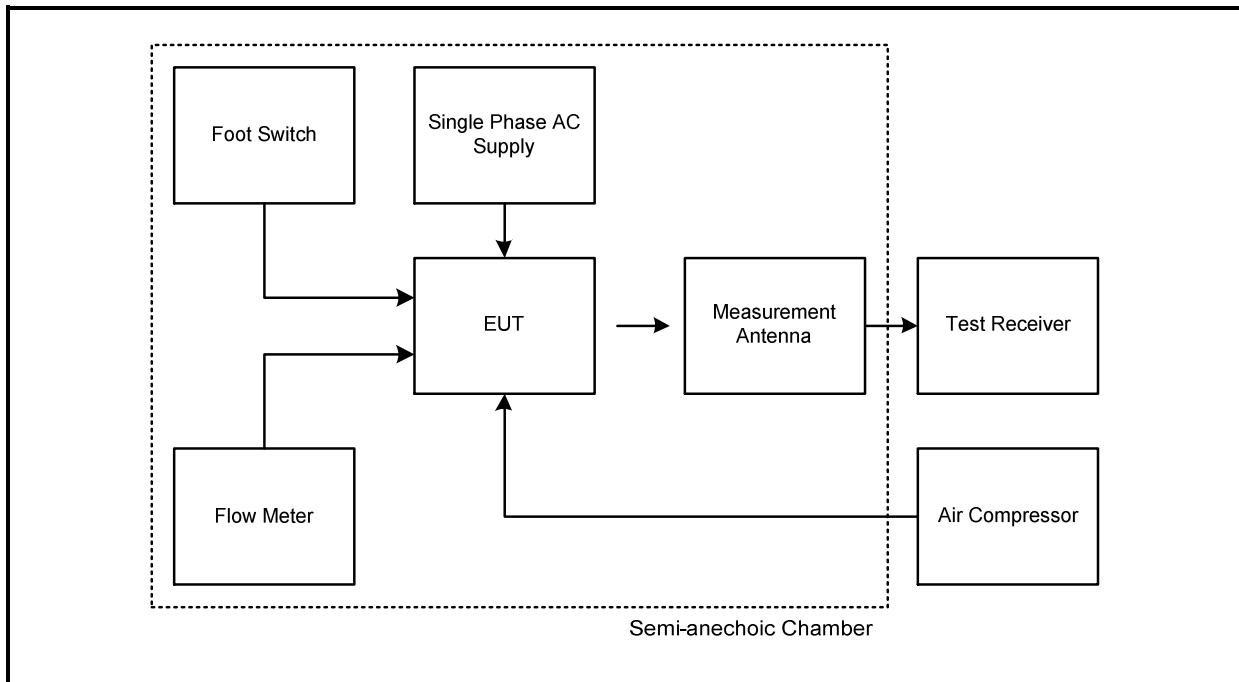
FCC Reference:	Parts 15.225(d) & 15.209(a)
Test Method Used:	ANSI C63.10 Sections 6.3, 6.4 and 6.5
Frequency Range:	9 kHz to 1000 MHz

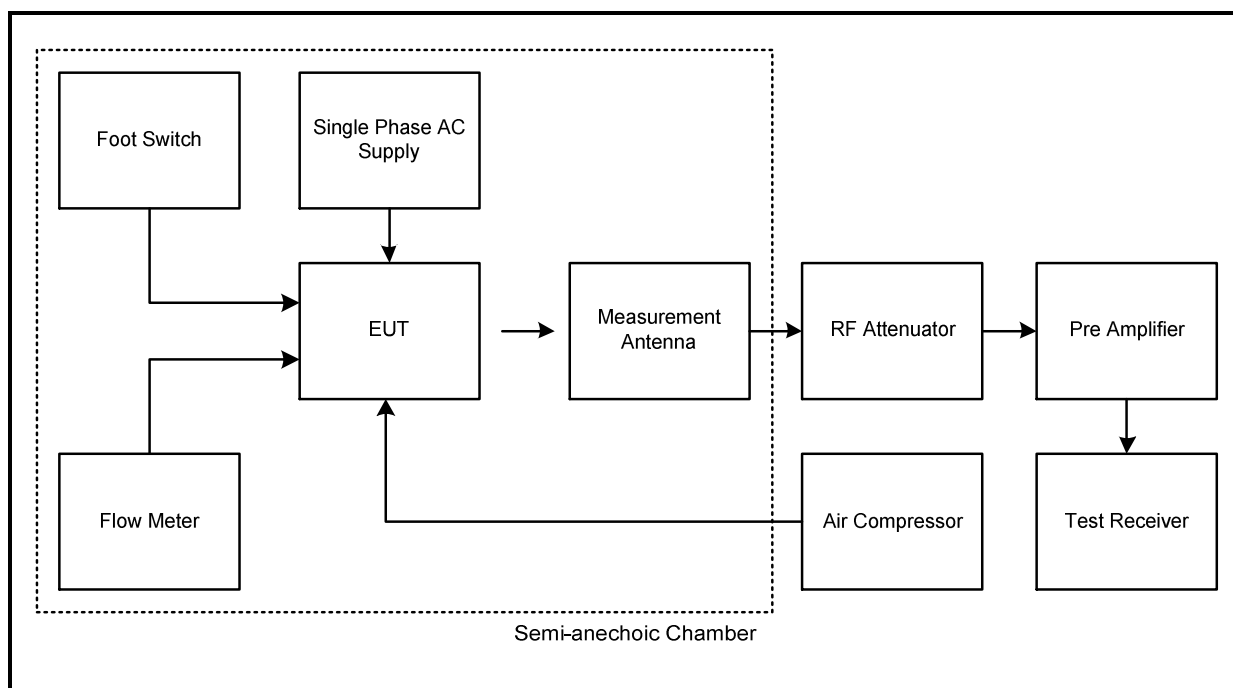
Environmental Conditions:

Temperature (°C):	10 to 25
Relative Humidity (%):	29 to 38

Note(s):

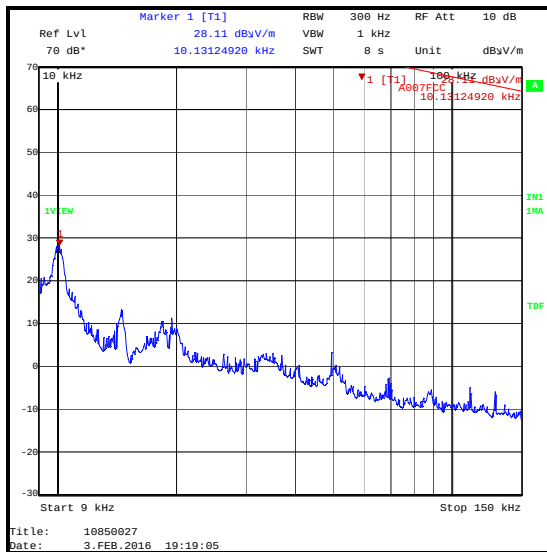
1. In accordance with FCC KDB 937606, a *bona fide* attempt was made to perform measurements at the distances specified in Part 15.209(a) on an open field test site. It was not possible to determine the spurious emission values at the test distances specified below 30 MHz on an open field test site, therefore in accordance with 47 CFR 15.31(f), measurements were made at closer distances. Attempts were made to measure spurious emissions at 3, 30 and 300 metres on an open field test site on 02 February 2016. Unfortunately, spurious emissions from the EUT could not be seen above the ambient emissions present at the open field test site or the noise floor of the measurement system. Final measurement results from the semi-anechoic chamber tests on 03 February 2016 are shown in this section. In addition, the open field test result plots for measurements between 9 kHz and 30 MHz are also shown. These measurement plots are identical to background scan plots of the open field test site. Background scans of the open field test site and further information are shown in Appendix 1 of this test report.
2. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss. Only spurious emissions in the range 30 MHz to 1 GHz were recorded. Markers were placed on the peaks of the prescan plot and final measurements were performed using a quasi-peak detector.
3. All other emissions were greater than 20 dB below the applicable limit, below the noise floor of the measurement system or ambient and therefore not recorded.
4. Measurements on 03 February 2016 were performed in a semi-anechoic chamber (UL VS LTD Asset Number K0001) at a distance of 3 metres. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. Between 30 MHz and 1 GHz, maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.
5. Measurement plots in this section for tests between 9 kHz and 30 MHz on an open field test site have markers placed on the highest level ambient emissions. This is for information only.
6. All emissions on the 9 kHz to 150 kHz plot were investigated and found to be radiating from the test site turntable.
7. A transducer factor was used on the spectrum analyser during open field tests. This factor includes correction between the fixed gain of the magnetic loop antenna and the calibration values. It also includes the value of the RF cable used to connect the antenna to the spectrum analyser which was incorporated into the annual calibration of the magnetic loop antenna.

Transmitter Radiated Spurious Emissions (continued)**Test setup for radiated measurements: Open Field Test Site****Test setup for radiated measurements: Semi-anechoic chamber below 30 MHz**

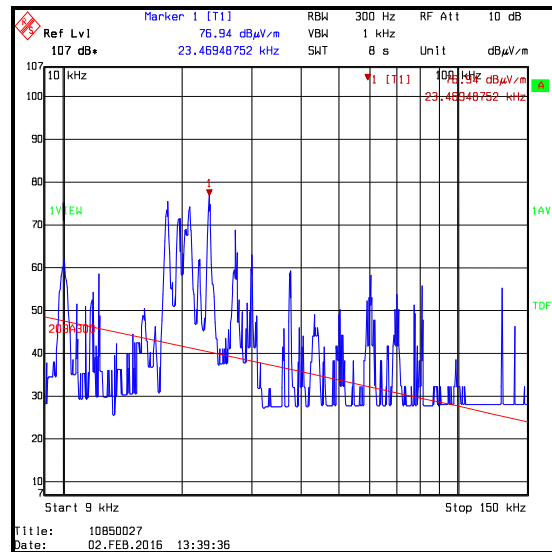
Transmitter Radiated Spurious Emissions (continued)**Test setup for radiated measurements: Semi-anechoic chamber above 30 MHz**

Transmitter Radiated Spurious Emissions (continued)**Results: Quasi Peak**

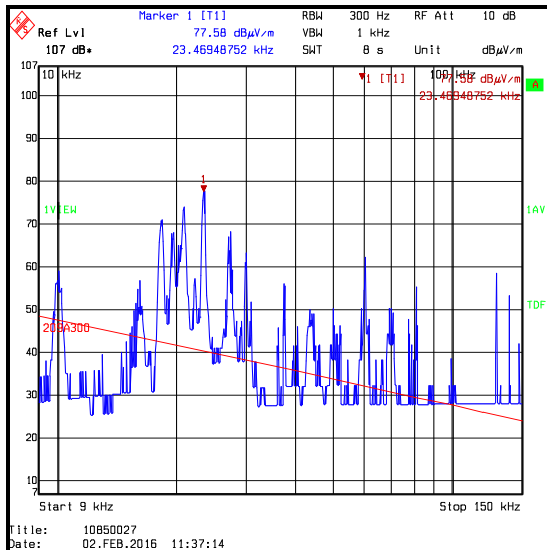
Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
556.039	Horizontal	31.6	46.0	14.4	Complied
583.154	Horizontal	29.8	46.0	16.2	Complied
610.288	Horizontal	30.3	46.0	15.7	Complied
637.378	Horizontal	32.6	46.0	13.4	Complied
664.519	Horizontal	29.9	46.0	16.1	Complied

Transmitter Radiated Spurious Emissions (continued)

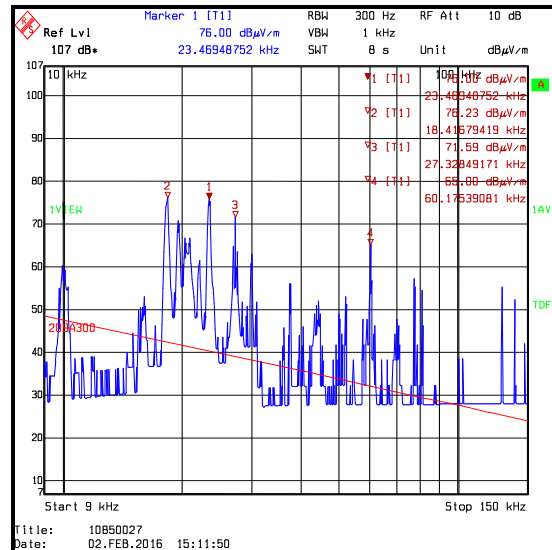
9 kHz to 150 kHz / peak detector / measured at 3 metres extrapolated to 30 metres / measured in a semi-anechoic chamber



9 kHz to 150 kHz / average detector / EUT operating / measured at 3 metres on an open field test site

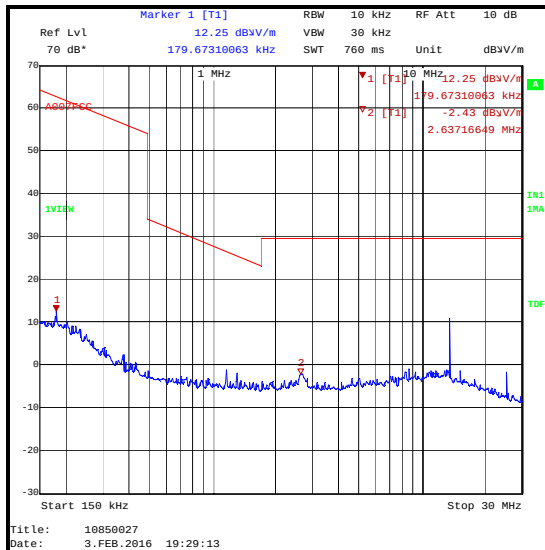


9 kHz to 150 kHz / average detector / EUT operating / measured at 30 metres on an open field test site



9 kHz to 150 kHz / average detector / EUT operating / measured at 300 metres on an open field test site

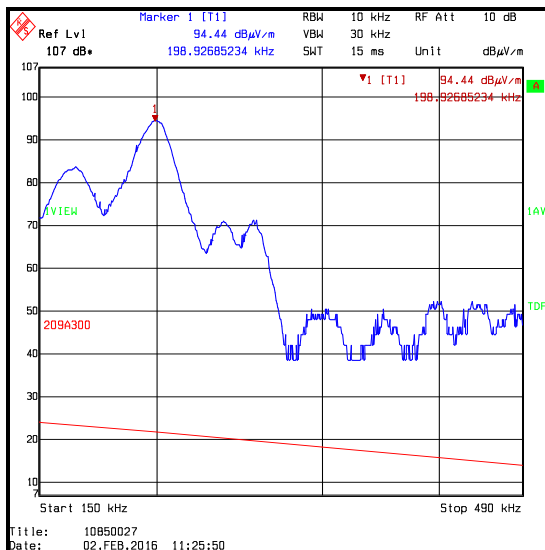
Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying table.

Transmitter Radiated Spurious Emissions (continued)

150 kHz to 30 MHz / peak detector (worst case) / EUT operating / measured at 3 metres extrapolated to 30 metres / measured in a semi-anechoic chamber



150 kHz to 490 kHz / average detector / EUT operating / measured at 3 metres on an open field test site

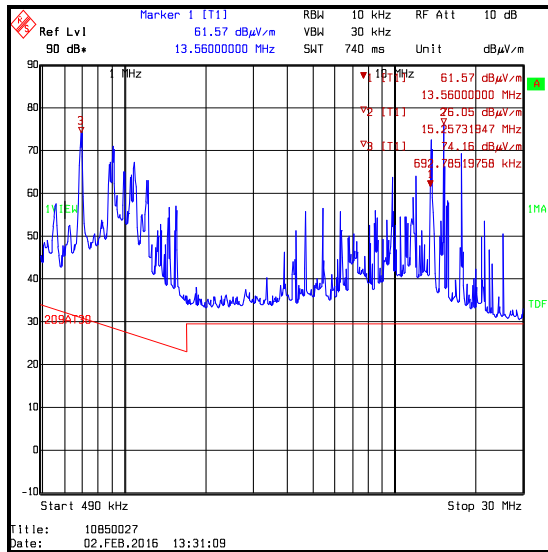


150 kHz to 490 kHz / average detector / EUT operating / measured at 30 metres on an open field test site

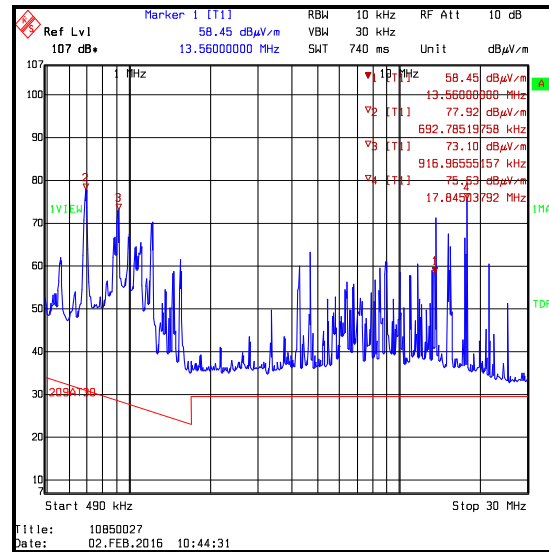


150 kHz to 490 kHz / average detector / EUT operating / measured at 300 metres on an open field test site

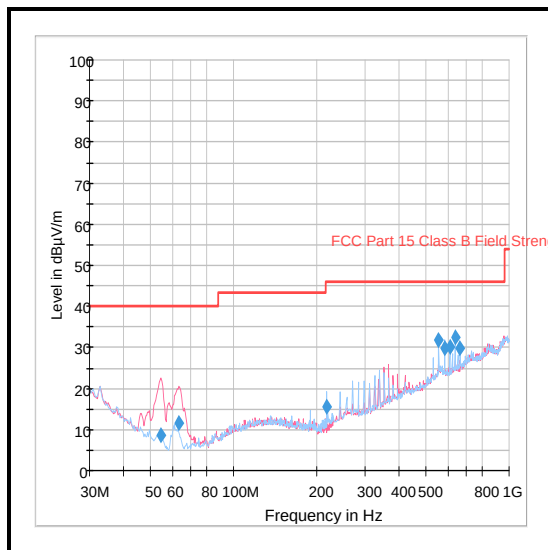
Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying table.

Transmitter Radiated Spurious Emissions (continued)

490 kHz to 30 MHz / peak detector / EUT operating / measured at 3 metres on an open field test site



490 kHz to 30 MHz / peak detector / EUT operating / measured at 30 metres on an open field test site



30 MHz to 1 GHz / peak detector (worst case) / measured at 3 metres in a semi-anechoic chamber

Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying table.

Transmitter Radiated Spurious Emissions (continued)**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1623	Thermohygrometer	JM Handelspunkt	30.5015.13	Not stated	11 Jan 2017	12
K0001	5m RSE Chamber	Rainford EMC	N/A	N/A	12 Jan 2017	12
M1273	Test Receiver	Rohde & Schwarz	ESIB26	100275	19 Mar 2016	12
M1659	Thermohygrometer	JM Handelspunkt	30.5015.13	Not stated	23 Apr 2016	12
M127	Spectrum Analyser	Rohde & Schwarz	FSEB30	842659/016	11 Aug 2016	12
M1568	Magnetic Loop Antenna	Rohde & Schwarz	HFH2-Z2	879284/2	06 May 2016	12
A490	Antenna	Chase	CBL6111A	1590	30 Apr 2016	12
G0543	Amplifier	Sonoma	310N	230801	10 Feb 2016	3
A1834	Attenuator	Hewlett Packard	8491B	10444	05 Mar 2016	12

5.2.4. Transmitter Band Edge Radiated Emissions**Test Summary:**

Test Engineer:	Andrew Edwards	Test Date:	23 February 2016
Test Sample Serial Number:	CS-CU-003-00015		

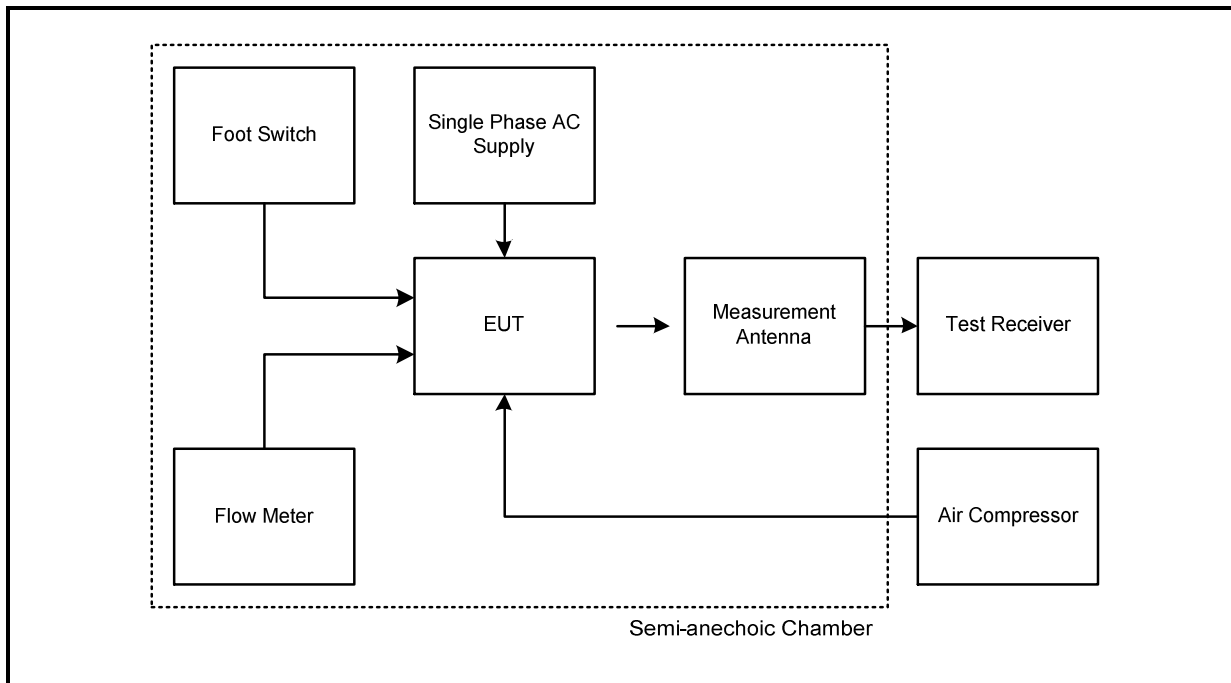
FCC Reference:	Parts 15.225(c)(d) & 15.209(a)
Test Method Used:	ANSI C63.10 Section 6.4

Environmental Conditions:

Temperature (°C):	22
Relative Humidity (%):	34

Note(s):

1. In accordance with FCC KDB 937606, a *bona fide* attempt was made to perform measurements at the distances specified in Part 15.209(a). It was not possible to determine the band edge emission values at the test distances specified below 30 MHz on an open field test site due to the presence of ambient emissions, therefore in accordance with 47 CFR 15.31(f), measurements were made at closer distances. Attempts were made to measure the fundamental and band edges at 3 metres on an open field test site on 02 February 2016. Unfortunately the emission could not be seen above the ambient emissions or the noise floor of the measurement system. Therefore the results from the semi-anechoic chamber tests on 12 February 2016 are shown in this section of the test report. Background scans of the open field test site are shown in Appendix 1 of this test report.
2. The measurement was performed in a semi-anechoic chamber at a distance of 3 metres. An RF level offset on the spectrum analyser was used to replicate the fundamental field strength level measured at 3 metres and an additional -40 dB was incorporated to extrapolate the measured level to the required measurement distance of 30 metres.
3. The spectrum analyser resolution bandwidth was set to 10 kHz and video bandwidth 30 kHz. A peak detector was used, sweep time was set to auto and the trace mode was Max Hold. The span was set to 1 MHz. Markers were placed at the lower and upper band edges. The results are given in the tables below.

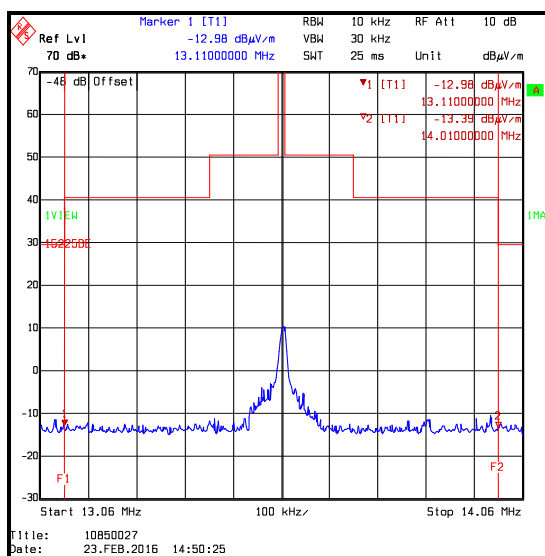
Transmitter Band Edge Radiated Emissions (continued)**Test setup for radiated measurements: Semi-anechoic chamber**

Transmitter Band Edge Radiated Emissions (continued)**Results: Peak / Lower Band Edge**

Frequency (MHz)	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
13.11	-13.0	29.5	42.5	Complied

Results: Peak / Upper Band Edge

Frequency (MHz)	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
14.01	-13.4	29.5	42.9	Complied

**Test Equipment Used:**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1623	Thermohygrometer	JM Handelspunkt	30.5015.13	Not stated	11 Jan 2017	12
K0001	5m RSE Chamber	Rainford EMC	N/A	N/A	12 Jan 2017	12
M127	Spectrum Analyser	Rohde & Schwarz	FSEB30	842659/016	11 Aug 2016	12
M1568	Magnetic Loop Antenna	Rohde & Schwarz	HFH2-Z2	879284/2	06 May 2016	12

5.2.5. Transmitter Frequency Stability (Temperature & Voltage Variation)**Test Summary:**

Test Engineer:	Andrew Edwards	Test Date:	04 February 2016
Test Sample Serial Number:	CS-CU-003-00015		

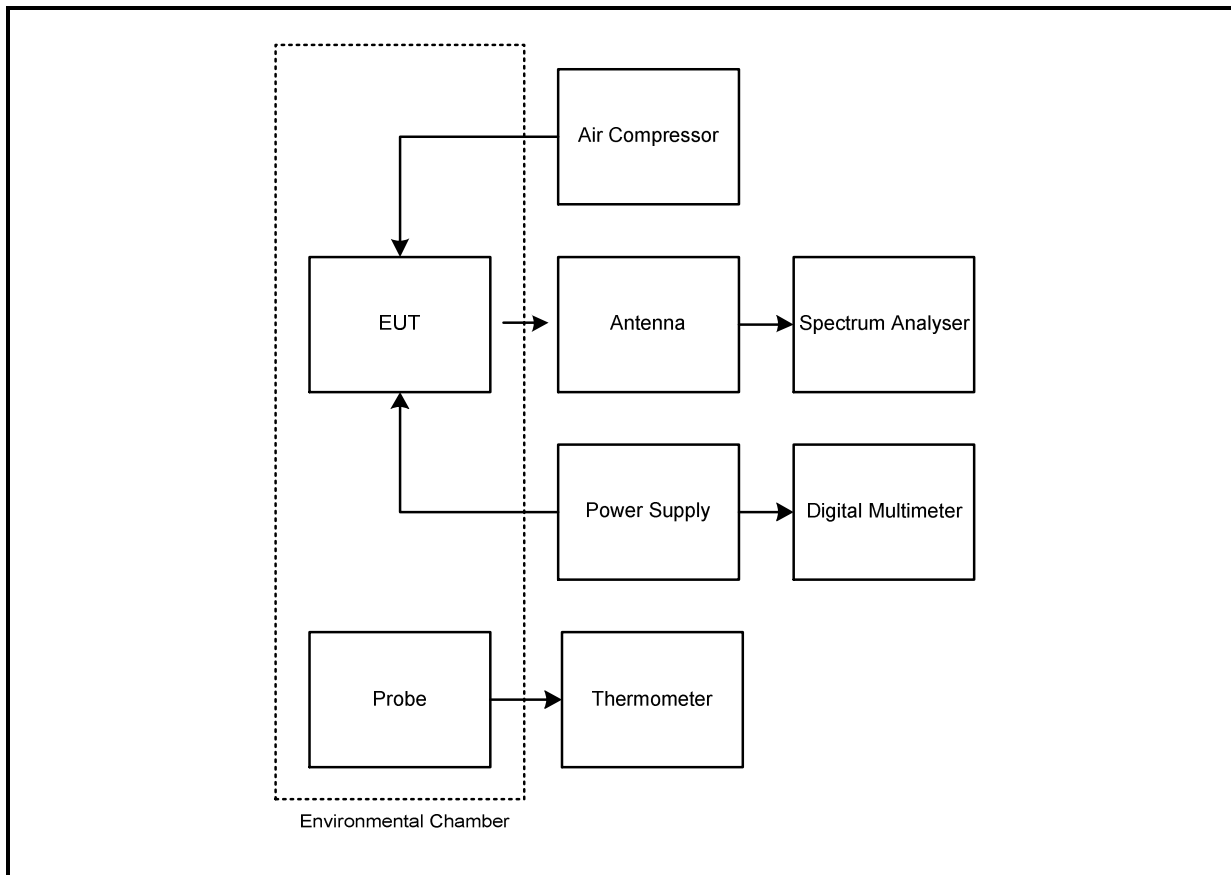
FCC Reference:	Part 15.225(e)
Test Method Used:	ANSI C63.10 Sections 6.8.1 and 6.8.2

Environmental Conditions:

Ambient Temperature (°C):	20
Ambient Relative Humidity (%):	34

Note(s):

1. Testing at voltage extremes was performed with the EUT powered by a variable AC power supply.
2. Frequency stability measurements were performed with an unmodulated carrier. The measurements were performed using the spectrum analyser marker count function. The marker counter function was set to 1 Hz before any measurements were performed.
3. The manufacturer declared that the EUT would not operate at the required temperatures of -20 °C and 50 °C, therefore the EUT has been tested with a minimum temperature of 5 °C and a maximum temperature of 30 °C as stated in the User Manual.
4. Frequency error was measured using a calibrated Rohde & Schwarz spectrum analyser.
5. Temperature was monitored throughout the test with a calibrated digital thermometer.
6. Voltage was monitored throughout the test with a calibrated digital voltmeter.

Transmitter Frequency Stability (Temperature & Voltage Variation) (continued)**Test setup: Environmental chamber**

Transmitter Frequency Stability (Temperature & Voltage Variation) (continued)**Results: Maximum frequency error of the EUT with variations in ambient temperature**

Temperature (°C)	Time after Start-up			
	0 minutes	2 minutes	5 minutes	10 minutes
5	13.561882 MHz	13.561878 MHz	13.561875 MHz	13.561877 MHz
20	13.561852 MHz	13.561846 MHz	13.561841 MHz	13.561839 MHz
30	13.561831 MHz	13.561818 MHz	13.561841 MHz	13.561816 MHz

Frequency with Worst Case Deviation (MHz)	Frequency Error (Hz)	Frequency Error (%)	Limit (%)	Margin (%)	Result
13.561882	82	0.000605	0.01	0.009395	Complied

Results: Maximum frequency error of the EUT with variations in nominal operating voltage at an ambient temperature of 20 °C

Supply Voltage	Nominal Frequency (MHz)	Measured Frequency (MHz)	Frequency Error (Hz)	Frequency Error (%)	Limit (%)	Margin (%)	Result
102	13.561800	13.561839	39	0.000288	0.01	0.009712	Complied
120	13.561800	13.561882	82	0.000605	0.01	0.009395	Complied
138	13.561800	13.561840	40	0.000295	0.01	0.009705	Complied

Test Equipment Used:

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M1659	Thermohygrometer	JM Handelspunkt	30.5015.13	Not stated	23 Apr 2016	12
M127	Spectrum Analyser	Rohde & Schwarz	FSEB30	842659/016	11 Aug 2016	12
M1643	Thermometer	Fluke	52II	18890136	23 Apr 2016	12
M1251	Multimeter	Fluke	175	89170179	26 May 2016	12
E0518	Environmental Chamber	TAS	LTCL 1200	24000107	Calibrated before use	-
S0539	Variable AC Power Supply	Kikusui	PCR 1000L	13010170	Calibrated before use	-

6. Measurement Uncertainty

No measurement or test can ever be perfect and the imperfections give rise to error of measurement in the results. Consequently the result of a measurement is only an approximation to the value of the measurand (the specific quantity subject to measurement) and is only complete when accompanied by a statement of the uncertainty of the approximation.

The expression of uncertainty of a measurement result allows realistic comparison of results with reference values and limits given in specifications and standards.

The uncertainty of the result may need to be taken into account when interpreting the measurement results.

The reported expanded uncertainties below are based on a standard uncertainty multiplied by an appropriate coverage factor such that a confidence level of approximately 95% is maintained. For the purposes of this document "approximately" is interpreted as meaning "effectively" or "for most practical purposes".

Measurement Type	Range	Confidence Level (%)	Calculated Uncertainty
AC Conducted Spurious Emissions	0.15 MHz to 30 MHz	95%	±4.69 dB
Frequency Stability	13 MHz to 14 MHz	95%	±0.92 ppm
Radiated Spurious Emissions	9 kHz to 30 MHz	95%	±3.73 dB
Radiated Spurious Emissions	30 MHz to 1000 MHz	95%	±5.65 dB
Transmitter Fundamental Field Strength	13 MHz to 14 MHz	95%	±3.73 dB

The methods used to calculate the above uncertainties are in line with those recommended within the various measurement specifications. Where measurement specifications do not include guidelines for the evaluation of measurement uncertainty the published guidance of the appropriate accreditation body is followed.

7. Report Revision History

Version Number	Revision Details		
	Page No(s)	Clause	Details
1.0	-	-	Initial Version
2.0	1 & 6 6 Appendix 1	-	The following changes were made at the request of the TCB: Changed Model from 'CU3' to 'CS-CU15-03' Changed Brand Name from 'OpClear' to 'OpClear Control Unit' Removed all test setup photos and reformatted section as required

8. Appendix 1

GPS coordinates of test location

Mag loop location (upper marker on photo)

N51° 08.971' W001° 26.293'

Decimal: 51.149517, -1.438217

30 metre test point (middle marker on photo)

N51° 08.951' W001° 26.302'

Decimal: 51.149183, -1.438367

300 metre test point (lower marker on photo)

N51° 08.803' W001° 26.352'

Decimal: 51.146717, -1.439200



Details of 3 metre and 30 metre open field test site used on 02 February 2016

Temperature: 10 °C

Relative Humidity: 29%

Ground conditions: Dry

Measurements at 3 and 30 metres

The test site was free from underground metal objects.

The EUT was powered by a single phase supply and an RCD was fitted to the power source. In accordance with the customer's instructions, a plastic hose was connected between the EUT and an air compressor. The footswitch was pressed for 2 seconds to place the EUT in test mode. Once the EUT was in test mode the air compressor was turned off and moved >10 metres from the EUT.

The EUT was placed on a plastic table at a height of 0.8 metres above ground level. All associated cables and support equipment were arranged according to ANSI C63.10-2013 Section 6.3.

The spectrum analyser used for measurements was located in a cabin close to the magnetic loop antenna.

The test distance was from the centre of the mag loop antenna to the closest periphery of the EUT. This distance was maintained as the EUT was rotated.

The EUT was rotated through 360 degrees in 60 degree steps at both measurement distances. The mag loop antenna was rotated through 90 degrees in 30 degree steps at every position the EUT was moved to.

Details of 300 metre open field test site used on 02 February 2016

Temperature: 10 °C

Relative Humidity: 29%

Ground conditions: Dry

Measurements at 300 metres

The test site was free from underground metal objects.

The EUT was powered by a single phase supply from a portable generator. The power cables were run across the test site. An RCD was fitted to the power source. In accordance with the customer's instructions, a plastic hose was connected between the EUT and an air compressor. The footswitch was pressed for 2 seconds to place the EUT in test mode. Once the EUT was in test mode the air compressor was turned off and moved >10 metres from the EUT.

The EUT was placed on a plastic table at a height of 0.8 metres above ground level. All associated cables were arranged according to ANSI C63.10-2013 Section 6.3

The spectrum analyser used for measurements was located in a cabin close to the magnetic loop antenna.

The test distance was from the centre of the mag loop antenna to the closest periphery of the EUT. This distance was maintained as the EUT was rotated.

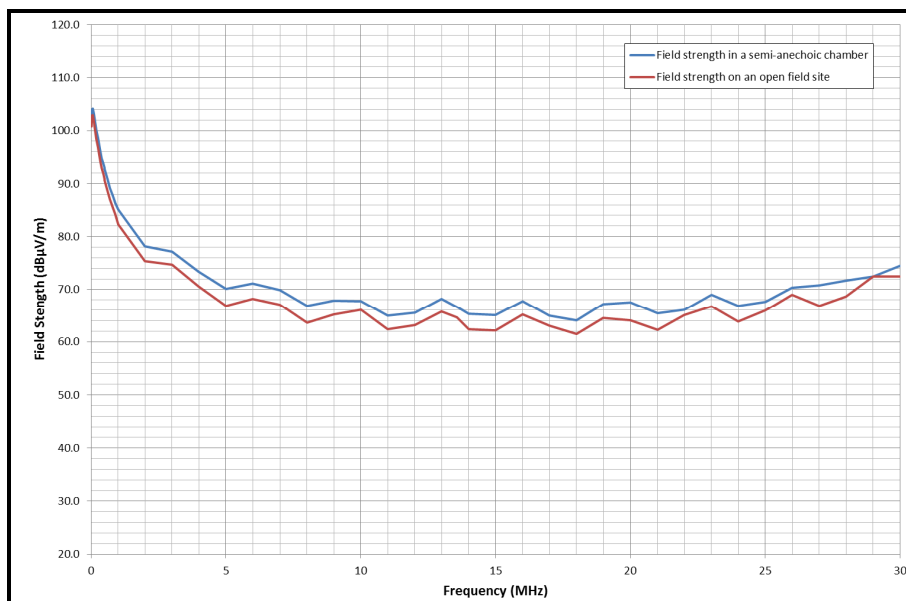
The EUT was rotated through 360 degrees in 60 degree steps. The mag loop antenna was rotated through 90 degrees in 30 degree steps at every position the EUT was moved to.

Comparison of open field test site with semi-anechoic chamber measurements at 3 metres

Radiated measurements were performed on an open field test site and within a 3 metre semi-anechoic chamber.

For the signal source, a modified loop antenna was connected to a signal generator at the transmit side. A standard active magnetic loop antenna was connected to a spectrum analyser at the receive side. The signal generator was set to its maximum supported output power and the signal was transmitted to the spectrum analyser via the two antennas and associated RF cables.

A sweep in small frequency increments was performed from 9 kHz to 30 MHz. The sweep was repeatedly performed with both antennas rotated about the axis in various orientations. Received levels for all orientations were recorded and the maximum levels for the open field test site and the semi-anechoic chamber are shown on the graph below. Full data for both tests are archived on the UL VS LTD IT server and available for inspection on request.



The conclusion was that the open field test site compares well with the semi-anechoic chamber at a measurement distance of 3 metres. If anything, the semi-anechoic chamber results are generally slightly higher. This means that if the measurement passes in the semi-anechoic chamber, it will pass with a higher margin on an open field test site.

The magnetic loop antenna used to perform these measurements is the same antenna or same type of antenna used during measurements contained in this test report.

Verification of open field test site and semi-anechoic chamber measurements at 3 metres prior to performing measurements

Two reference units are used for verification of the measurement system before testing commences. Both reference units are door entry systems modified by the manufacturer for test purposes only.

One reference unit transmits a continuous, modulated signal at a fixed frequency of 125 kHz when a 12 Volt battery is connected. The output power is fixed and known to be stable.

The second transmits a continuous, modulated signal at a fixed frequency of 13.56 MHz when a 12 Volt battery is connected. The output power is fixed and known to be stable.

Both frequencies are commonly used RFID frequencies.

A UL VS LTD internal verification document explains the procedure in detail. A brief description is given below.

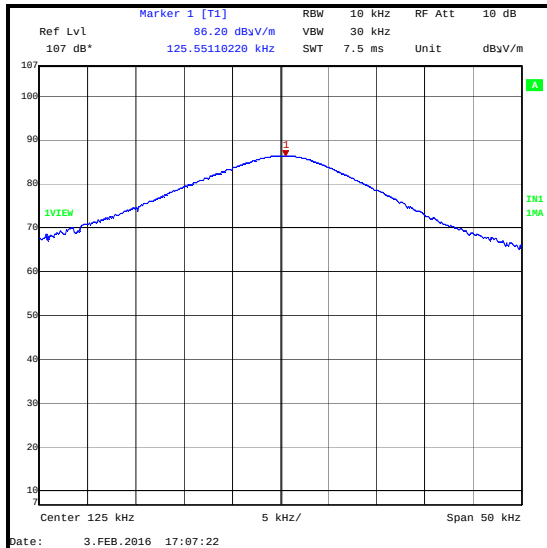
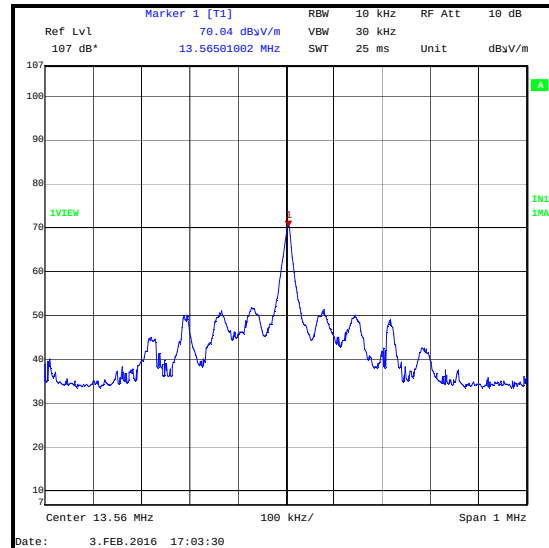
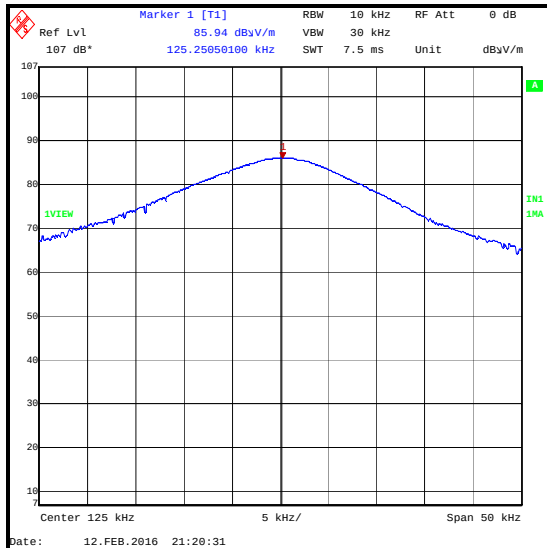
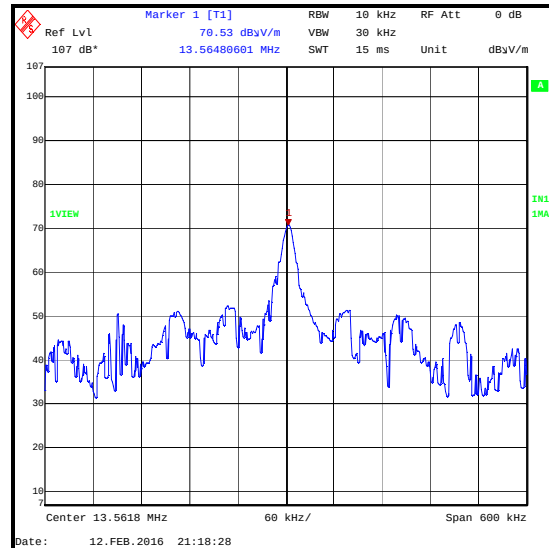
The centre of the magnetic loop antenna is placed exactly 3 metres from the reference unit. The reference unit is placed on a plastic table at a height of 0.8 metres above floor level and the centre of the mag loop antenna is 1 metre above the floor level. The mag loop antenna and reference unit are oriented in certain positions to ensure repeatability.

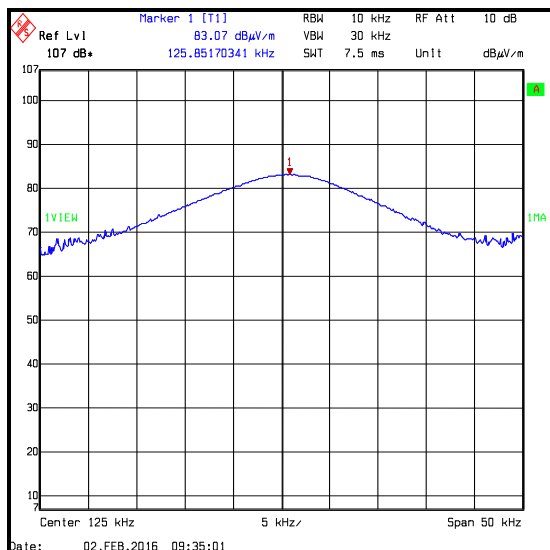
Each reference unit is connected to a 12 Volt battery and once transmitting, the maximum raw received level at each of the two frequencies is read on the spectrum analyser by using the marker peak function. The measured level has to be within certain levels as specified in the UL VS LTD internal test procedure. The plot of the verification measurement is archived on the UL VS LTD IT server. The peak level of each reference unit is recorded on a spreadsheet which is also archived on the UL VS LTD IT server.

The internal verification procedure and verification plots are available for inspection on request.

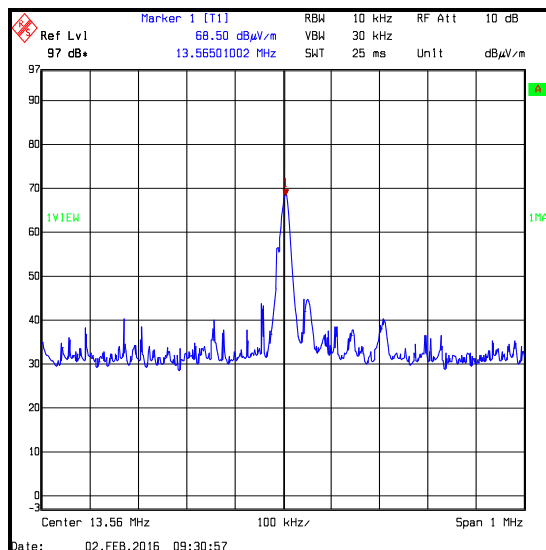
Radiated measurements below 30 MHz were performed in a semi-anechoic chamber at a distance of 3 metres.

Verification plots of the two reference units at a measurement distance of 3 metres are shown on the following page. Plots were taken on an open field test site (02 February 2016) and in a semi-anechoic chamber (03 February and 12 February 2016).

Verification of open field test site and semi-anechoic chamber measurements at 3 metres prior to performing measurements (continued)**125 kHz reference unit signal at 3 metres in a semi-anechoic chamber on 03 February 2016****13.56 MHz reference unit signal at 3 metres in a semi-anechoic chamber on 03 February 2016****125 kHz reference unit signal at 3 metres in a semi-anechoic chamber on 12 February 2016****13.56 MHz reference unit signal at 3 metres in a semi-anechoic chamber on 12 February 2016**

Verification of open field test site and semi-anechoic chamber measurements at 3 metres prior to performing measurements (continued)

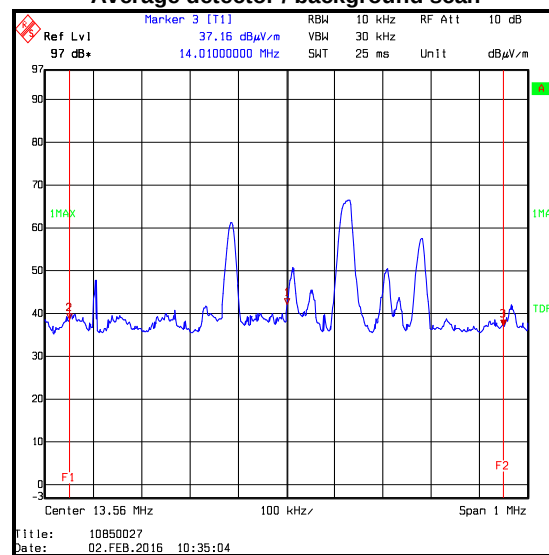
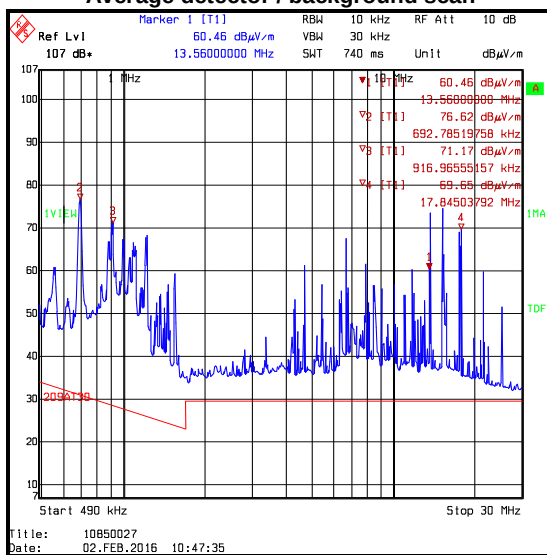
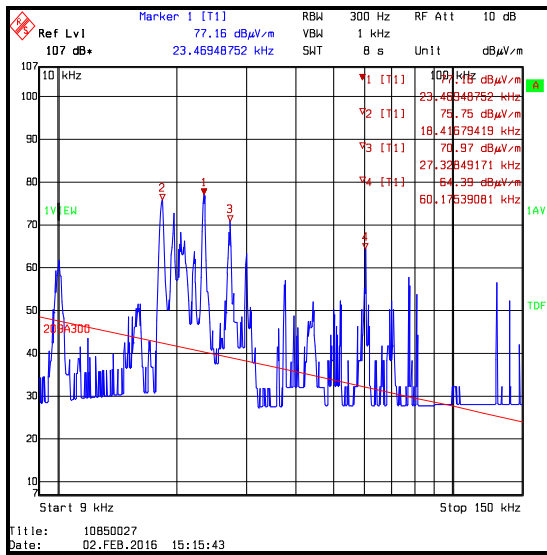
125 kHz reference unit signal at 3 metres on an open field test site on 02 February 2016



13.56 MHz reference unit signal at 3 metres on an open field test site on 02 February 2016

Note(s):

1. The above plots show comparable measurements of reference units on an open field test site and in a semi-anechoic chamber at spot frequencies.

Background scans of the open field test site**Note(s):**

1. The above plots are background scans of the open field test site. The EUT and generator (when used) were turned off when the background scans were performed.

--- END OF REPORT ---